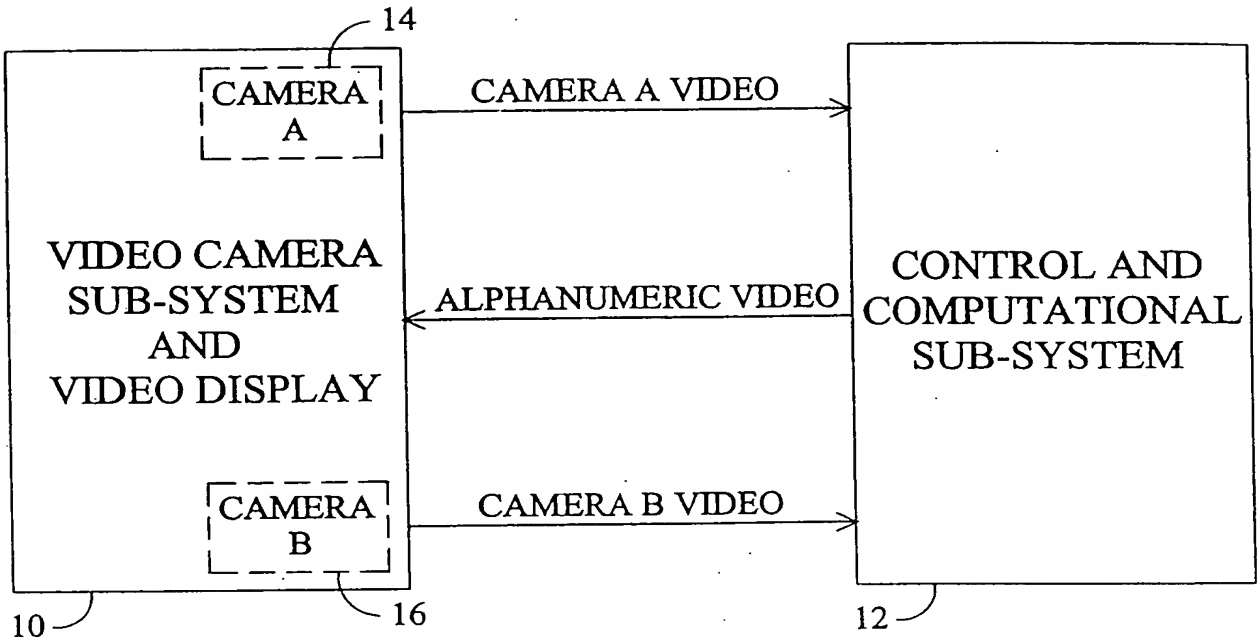

14
CAMERA A
CAMERA A VIDEO
VIDEO CAMERA SUB-SYSTEM AND VIDEO DISPLAY
ALPHANUMERIC VIDEO
CONTROL AND COMPUTATIONAL SUB-SYSTEM
CAMERA B
CAMERA B VIDEO
10
16
12

FIG. 1

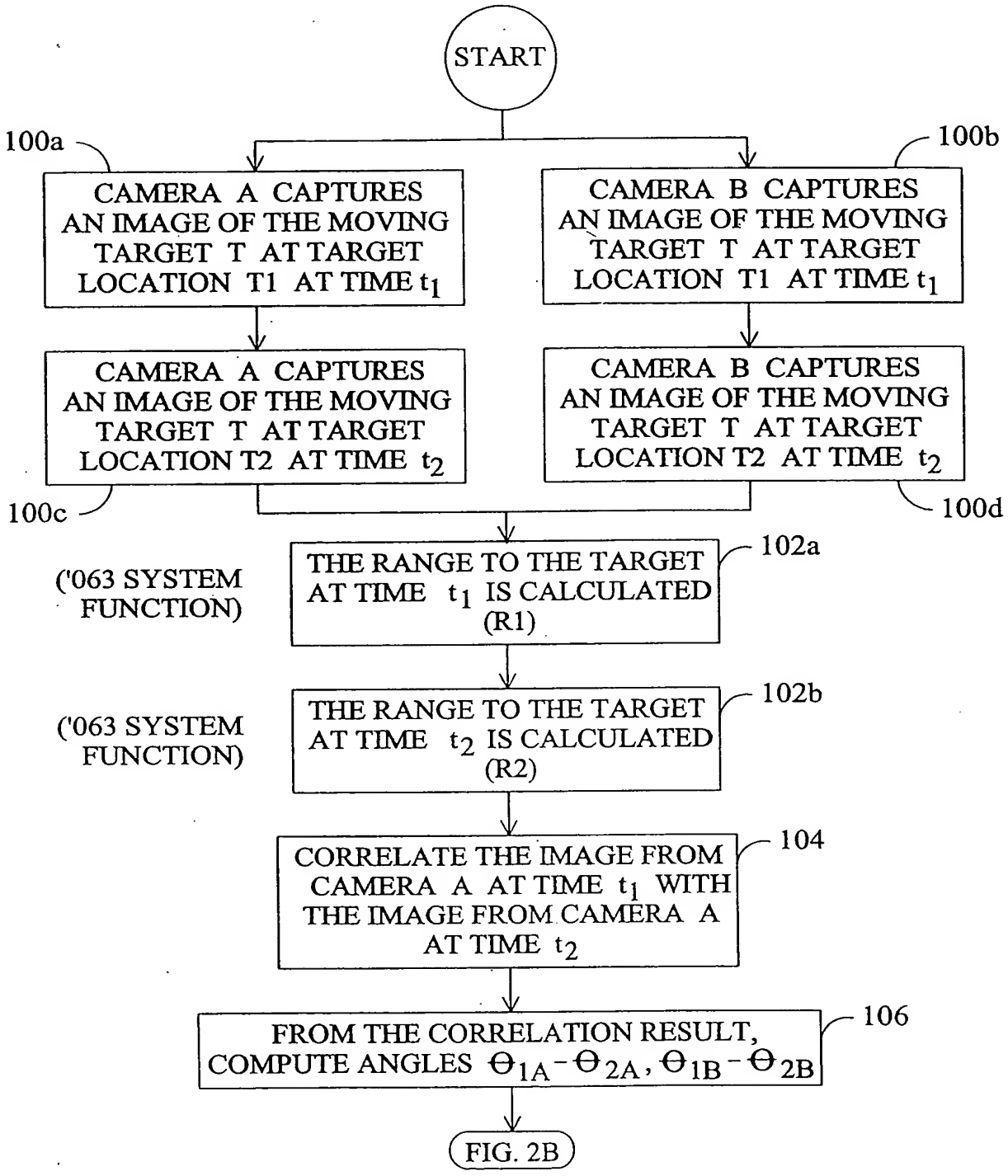

START
100a
CAMERA A CAPTURES AN IMAGE OF THE MOVING TARGET T AT TARGET LOCATION T1 AT TIME t_1
100b
CAMERA B CAPTURES AN IMAGE OF THE MOVING TARGET T AT TARGET LOCATION T1 AT TIME t_1
CAMERA A CAPTURES AN IMAGE OF THE MOVING TARGET T AT TARGET LOCATION T2 AT TIME t_2
CAMERA B CAPTURES AN IMAGE OF THE MOVING TARGET T AT TARGET LOCATION T2 AT TIME t_2
100c
100d
('063 SYSTEM FUNCTION)
THE RANGE TO THE TARGET AT TIME t_1 IS CALCULATED (R1)
102a
('063 SYSTEM FUNCTION)
THE RANGE TO THE TARGET AT TIME t_2 IS CALCULATED (R2)
102b
CORRELATE THE IMAGE FROM CAMERA A AT TIME t_1 WITH THE IMAGE FROM CAMERA A AT TIME t_2
104
FROM THE CORRELATION RESULT, COMPUTE ANGLES $\Theta_{1A}-\Theta_{2A}$, $\Theta_{1B}-\Theta_{2B}$
106
FIG. 2B

FIG. 2A

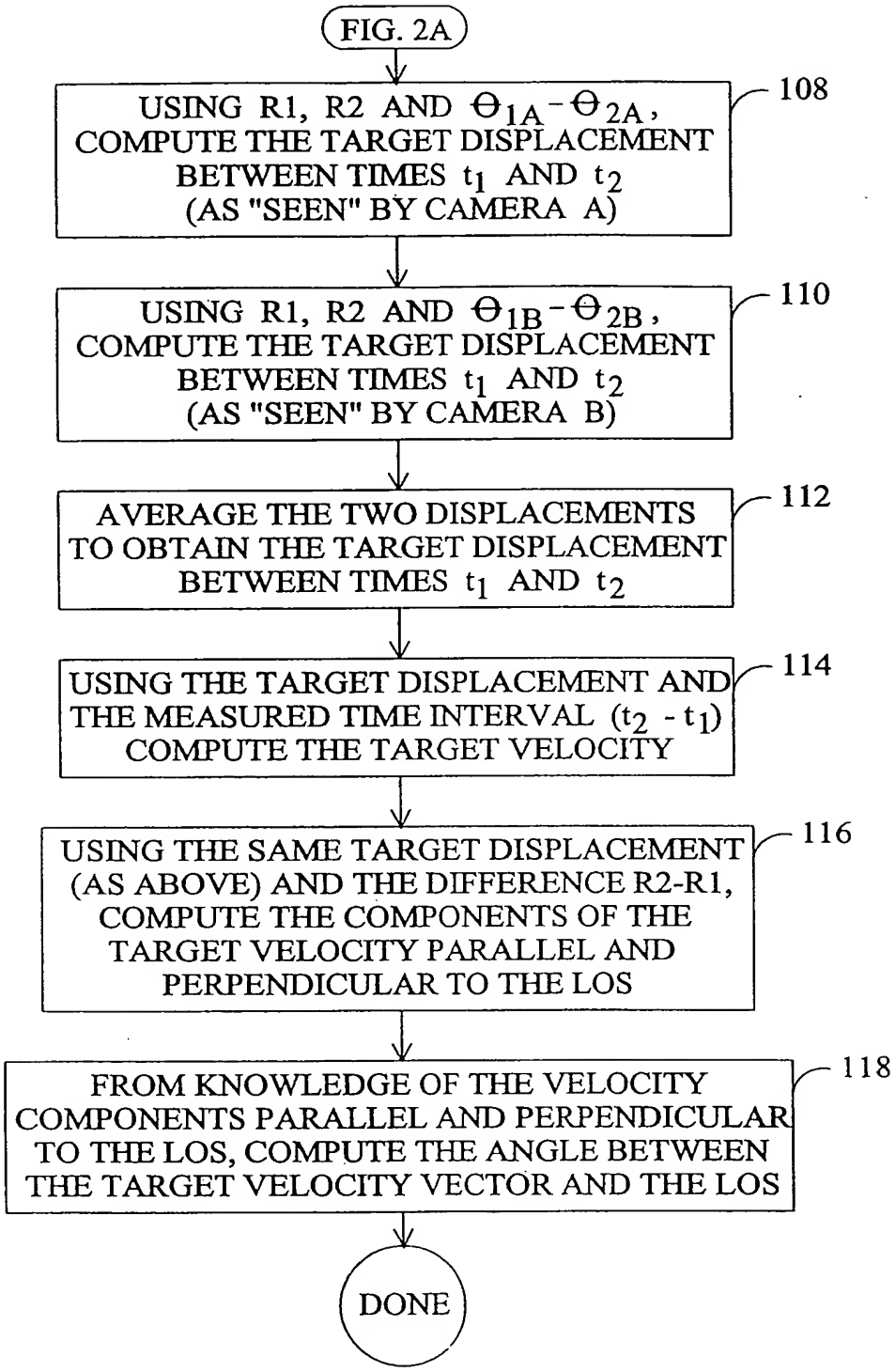


FIG. 2A
USING R1, R2 AND $\Theta_{1A}-\Theta_{2A}$, COMPUTE THE TARGET DISPLACEMENT BETWEEN TIMES t_1 AND t_2 (AS "SEEN" BY CAMERA A)
108
USING R1, R2 AND $\Theta_{1B}-\Theta_{2B}$, COMPUTE THE TARGET DISPLACEMENT BETWEEN TIMES t_1 AND t_2 (AS "SEEN" BY CAMERA B)
110
AVERAGE THE TWO DISPLACEMENTS TO OBTAIN THE TARGET DISPLACEMENT BETWEEN TIMES t_1 AND t_2
112
USING THE TARGET DISPLACEMENT AND THE MEASURED TIME INTERVAL $(t_2 - t_1)$ COMPUTE THE TARGET VELOCITY
114
USING THE SAME TARGET DISPLACEMENT (AS ABOVE) AND THE DIFFERENCE R2-R1, COMPUTE THE COMPONENTS OF THE TARGET VELOCITY PARALLEL AND PERPENDICULAR TO THE LOS
116
FROM KNOWLEDGE OF THE VELOCITY COMPONENTS PARALLEL AND PERPENDICULAR TO THE LOS, COMPUTE THE ANGLE BETWEEN THE TARGET VELOCITY VECTOR AND THE LOS
118
DONE

FIG. 2B

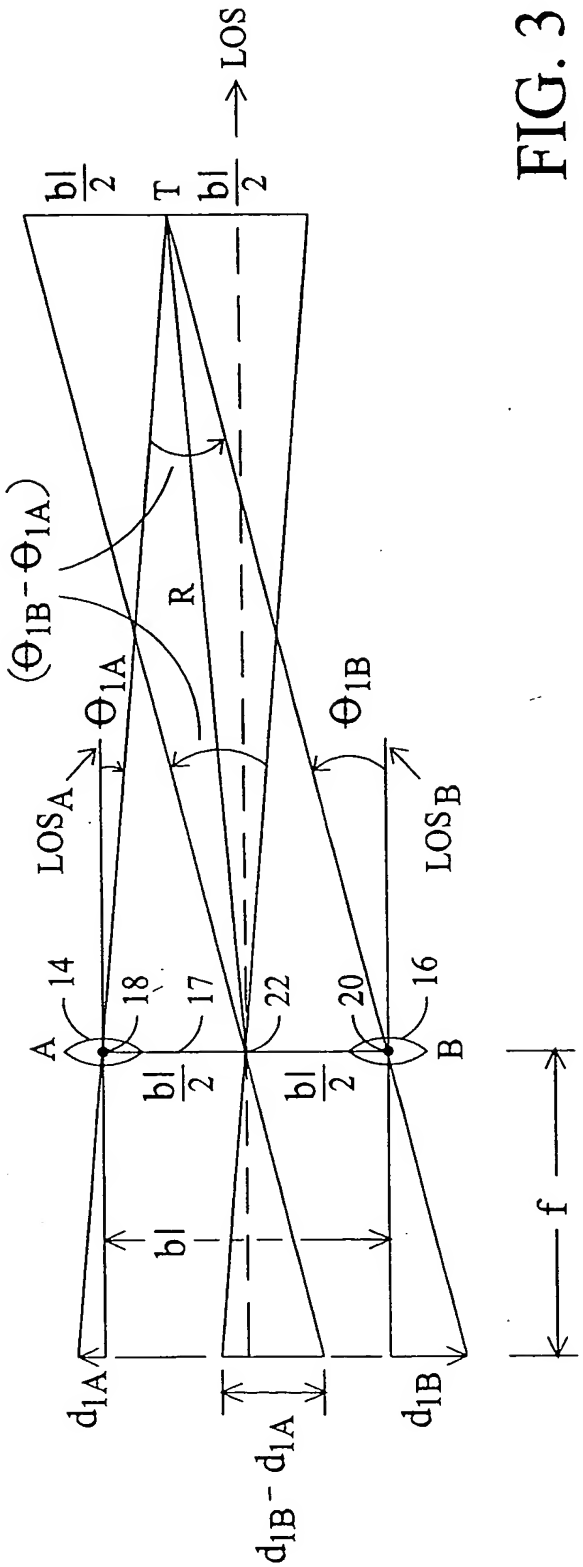

LOS
T
bl/2
bl/2
R
(Θ1B - Θ1A)
Θ1A
Θ1B
LOSA
LOSB
A
B
14
18
17
22
20
16
bl/2
bl/2
bl
f
d1A
d1B
d1B - d1A

FIG. 3

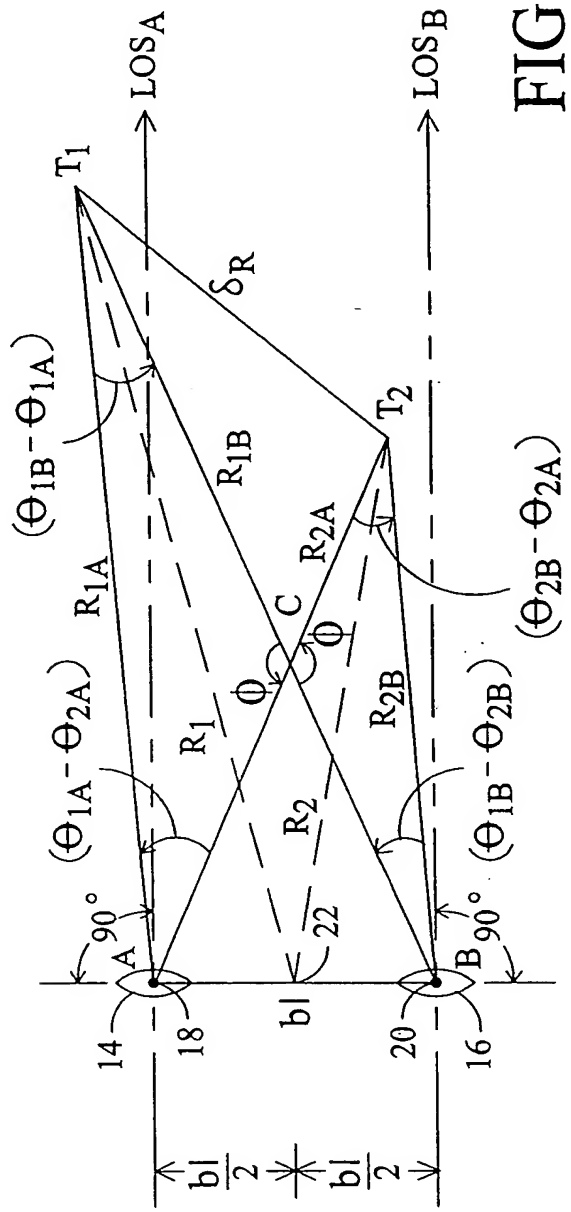

LOSA
LOSB
T1
T2
δR
(Θ1B - Θ1A)
(Θ2B - Θ2A)
R1A
R1B
R2A
R2B
R1
R2
C
Φ
Φ
(Θ1A - Θ2A)
(Θ1B - Θ2B)
90°
90°
A
B
14
18
22
20
16
bl
bl/2
bl/2

FIG. 4

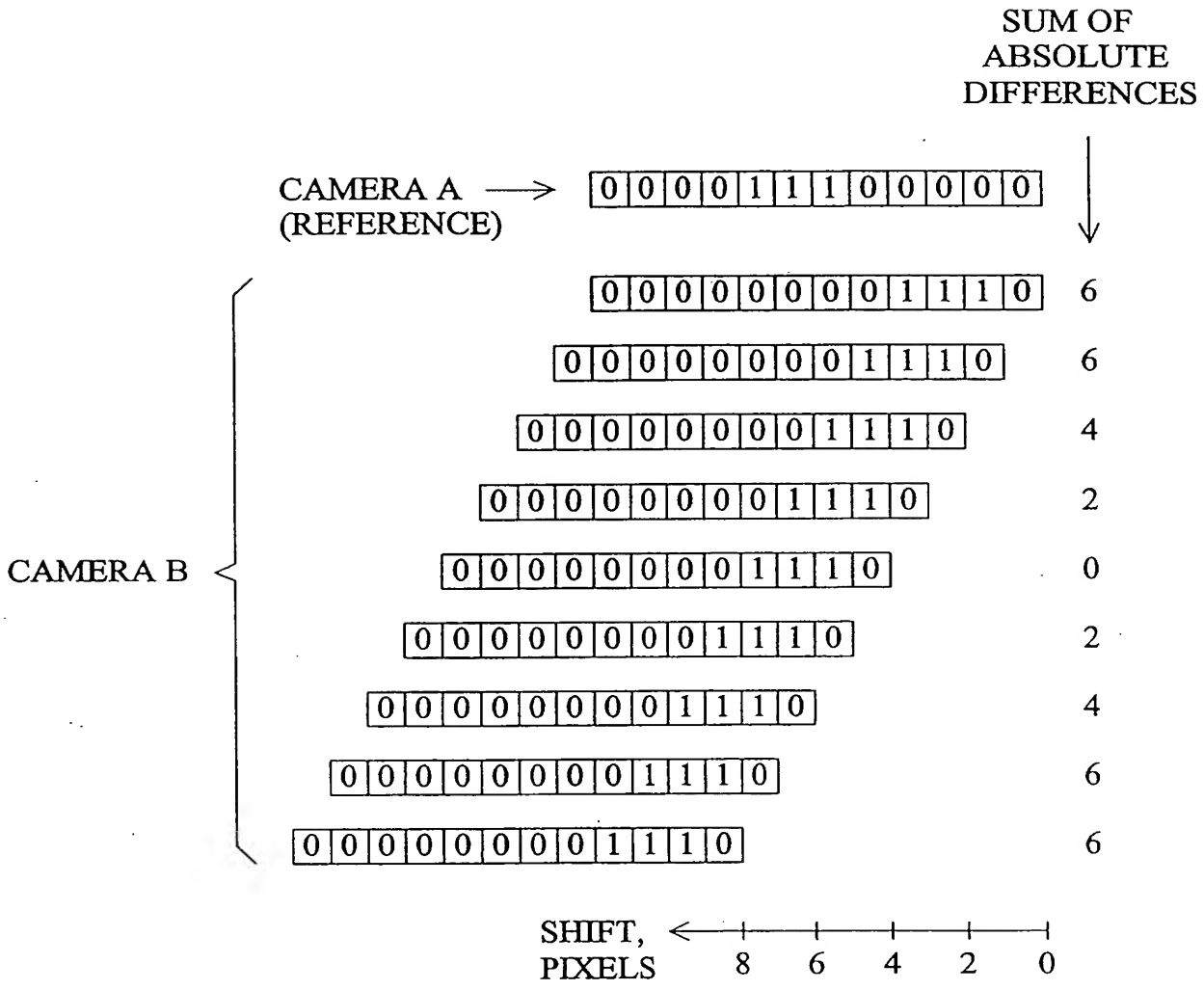

SUM OF ABSOLUTE DIFFERENCES
CAMERA A (REFERENCE)
0 0 0 0 1 1 1 0 0 0 0 0
CAMERA B
0 0 0 0 0 0 0 0 1 1 1 0
6
0 0 0 0 0 0 0 0 1 1 1 0
6
0 0 0 0 0 0 0 0 1 1 1 0
4
0 0 0 0 0 0 0 0 1 1 1 0
2
0 0 0 0 0 0 0 0 1 1 1 0
0
0 0 0 0 0 0 0 0 1 1 1 0
2
0 0 0 0 0 0 0 0 1 1 1 0
4
0 0 0 0 0 0 0 0 1 1 1 0
6
0 0 0 0 0 0 0 0 1 1 1 0
6
SHIFT, PIXELS
8 6 4 2 0

FIG. 5

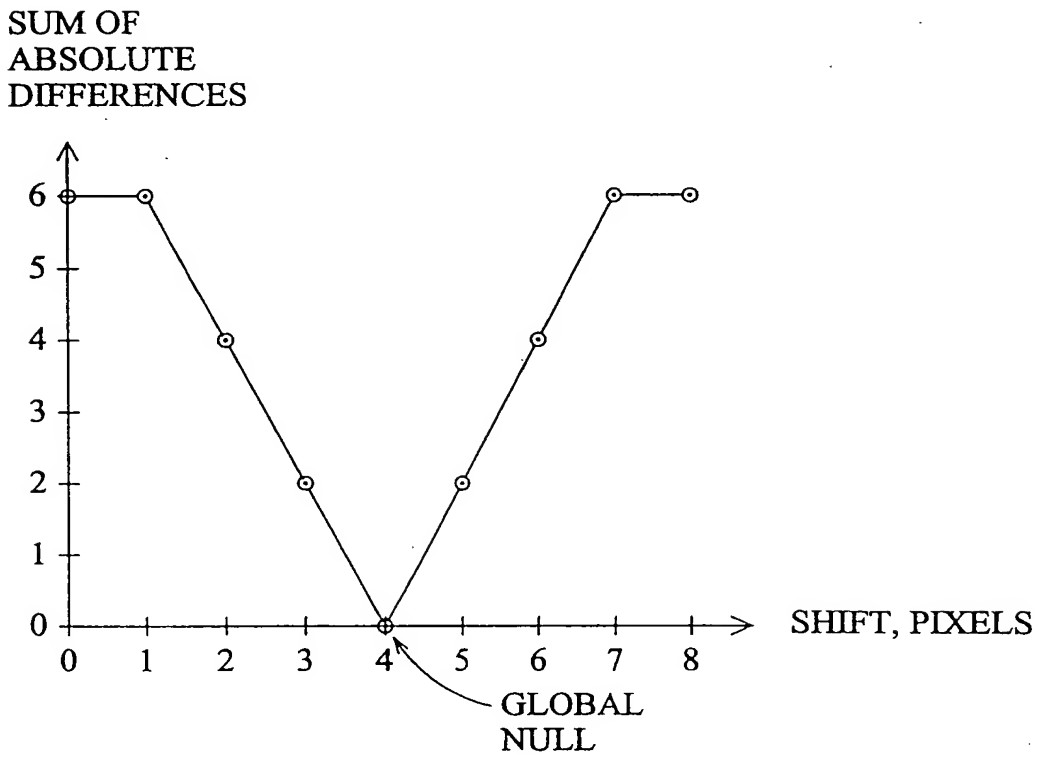

SUM OF
ABSOLUTE
DIFFERENCES
6
5
4
3
2
1
0
0
1
2
3
4
5
6
7
8
SHIFT, PIXELS
GLOBAL
NULL

FIG. 6

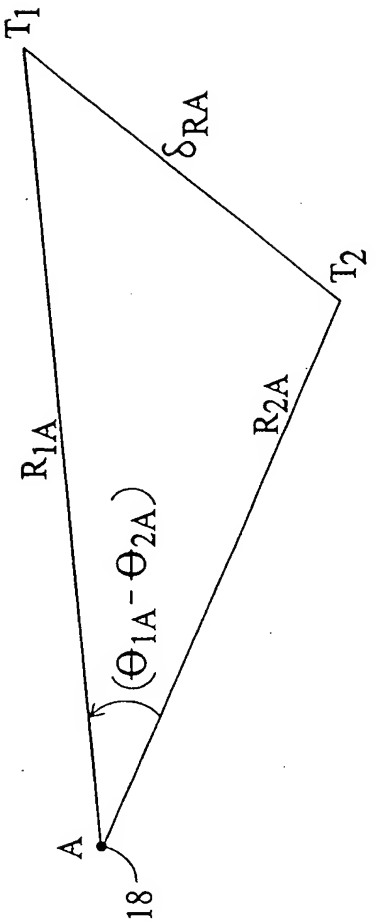


FIG. 7

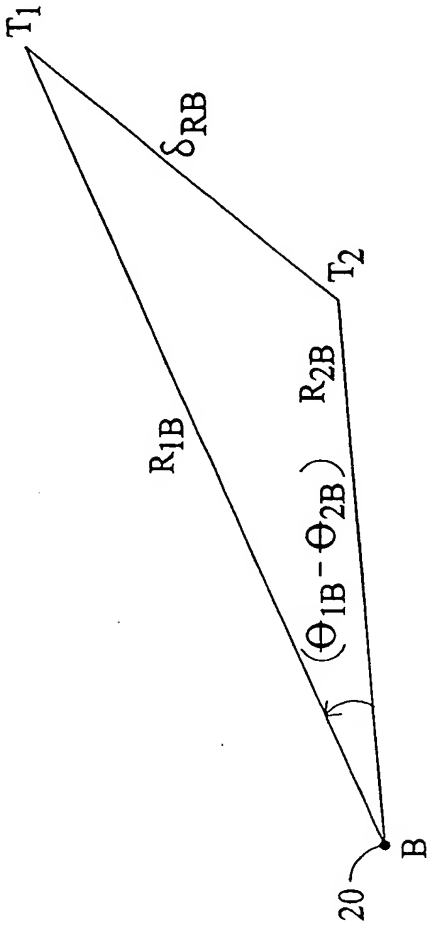


FIG. 8

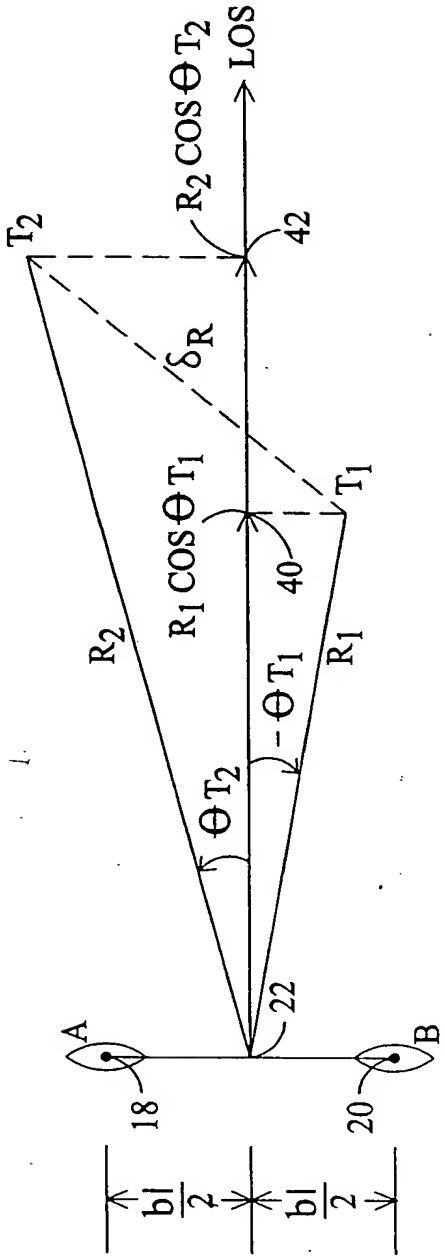

LOS
$R_2 \cos\Theta T_2$
T_2
42
δ_R
T_1
$R_1 \cos\Theta T_1$
40
R_2
R_1
$-\Theta T_1$
ΘT_2
22
A
B
18
20
$\frac{bl}{2}$
$\frac{bl}{2}$

FIG. 9

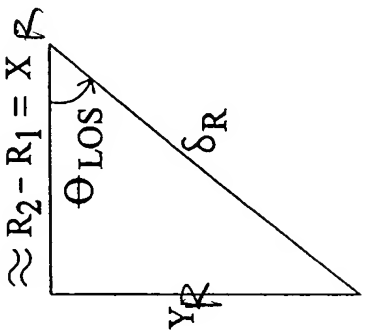

$\approx R_2 - R_1 = X_R$
Θ_{LOS}
δ_R
Y_R

FIG. 10

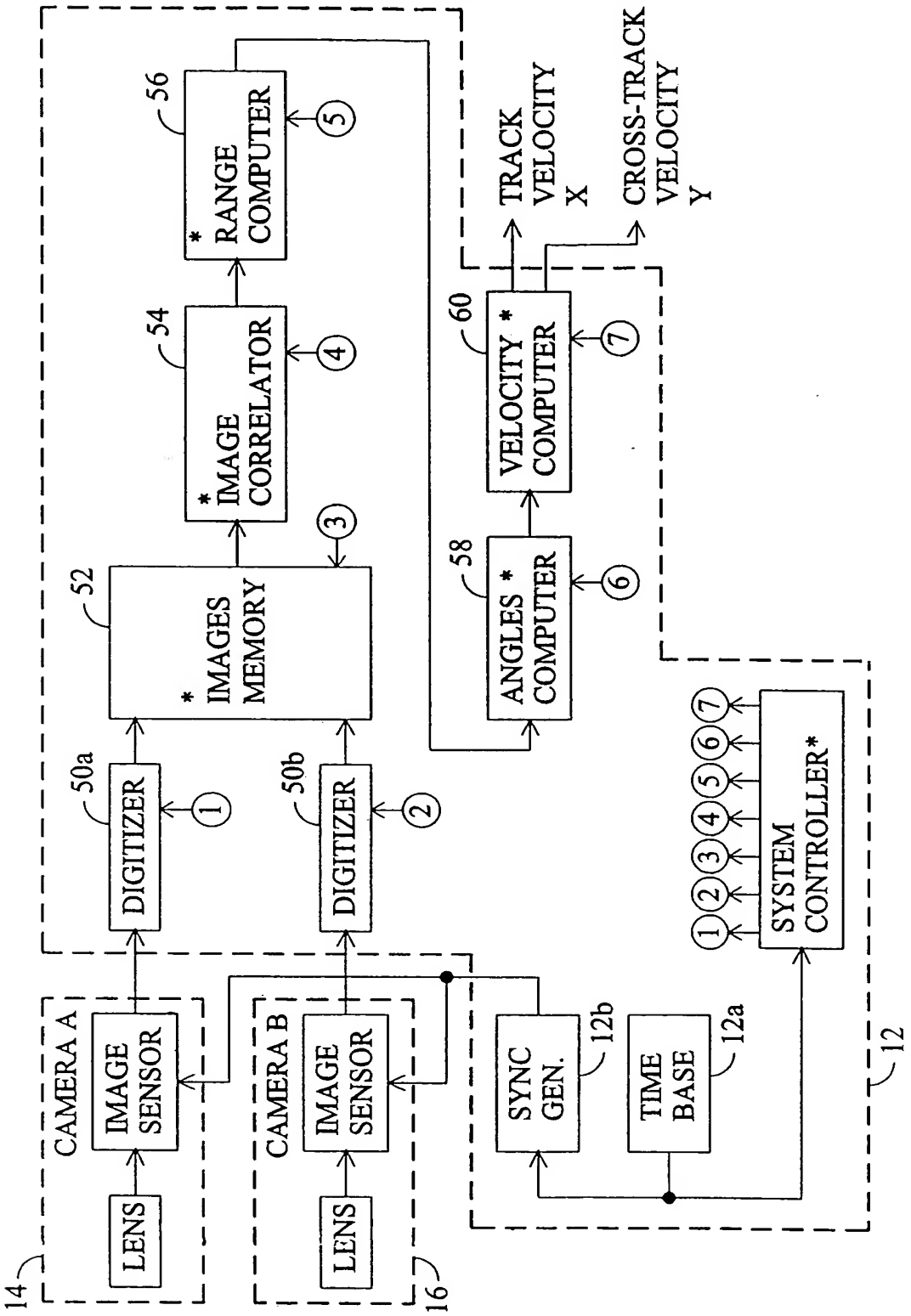

CAMERA A
LENS
IMAGE SENSOR
14
CAMERA B
LENS
IMAGE SENSOR
16
50a
DIGITIZER
50b
DIGITIZER
52
* IMAGES MEMORY
54
* IMAGE CORRELATOR
56
* RANGE COMPUTER
58
ANGLES * COMPUTER
60
VELOCITY * COMPUTER
TRACK VELOCITY X
CROSS-TRACK VELOCITY Y
SYNC GEN.
12b
TIME BASE
12a
SYSTEM CONTROLLER*
12
1 2 3 4 5 6 7

FIG. 11

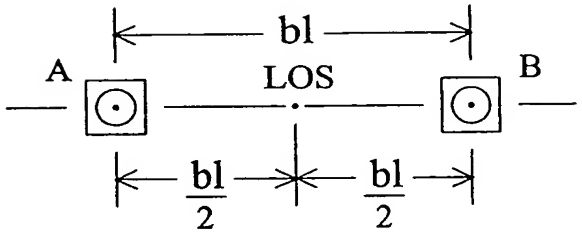


FIG. 12

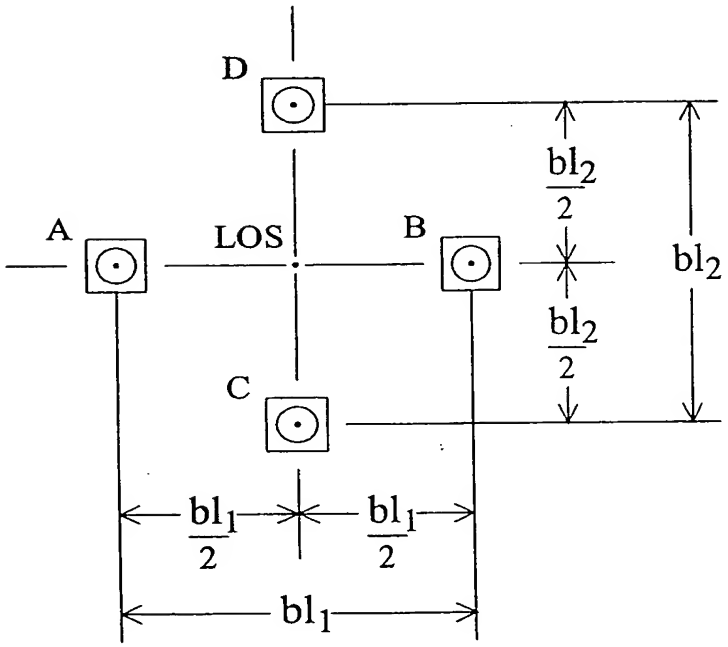


FIG. 13

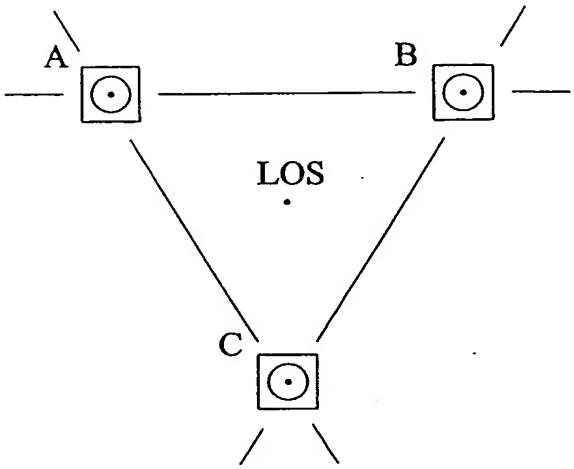


FIG. 14

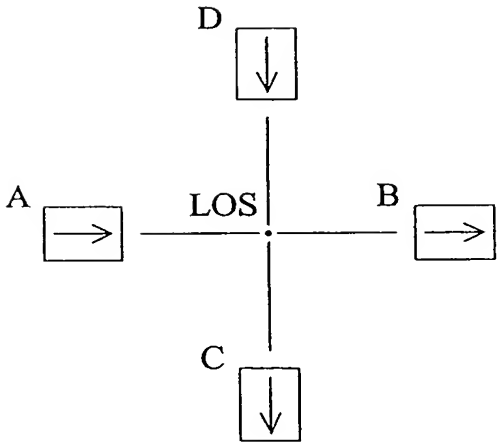


FIG. 15

Invention: INTRUSION DETECTION SYSTEM

Filed: December 31, 2003 Attorney: William O. Geny, Reg. # 27,444
Inventors: Larry C. Hardin & Lawrence V. Nash Telephone: (503) 227-5631

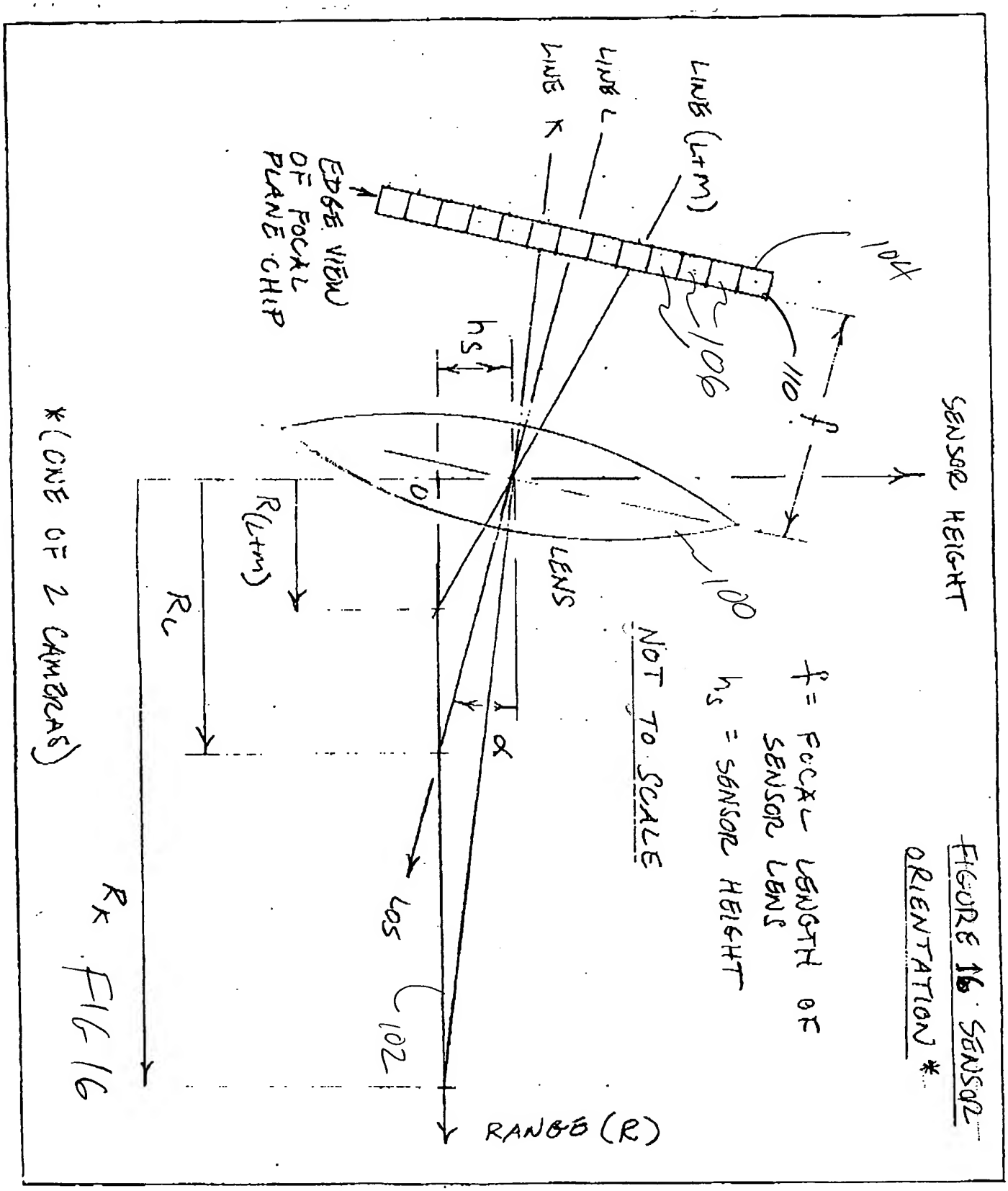


FIGURE 16 SENSOR ORIENTATION *

RK FIG 16

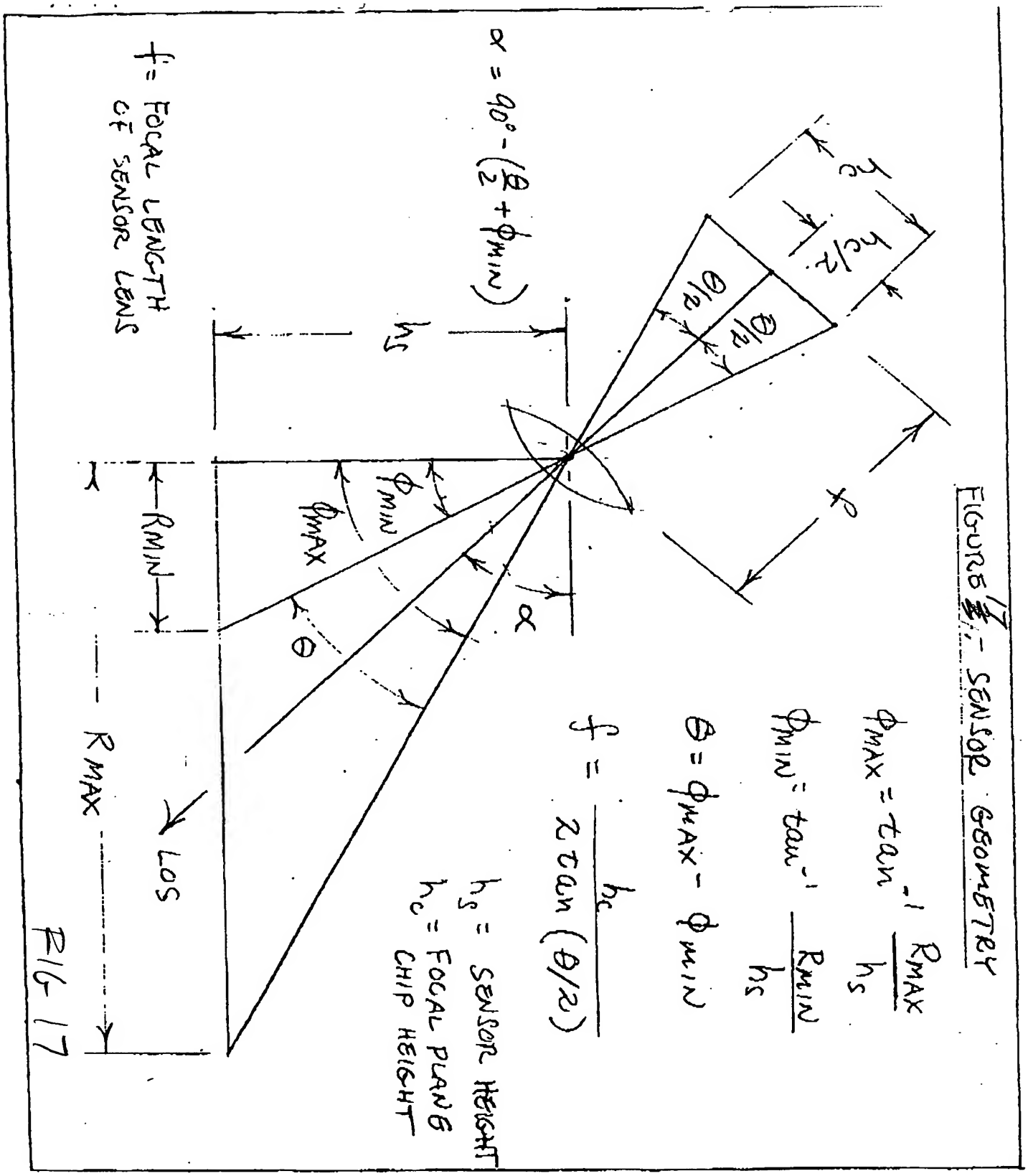


FIGURE 17 - SENSOR GEOMETRY
$\phi_{MAX} = \tan^{-1} \frac{R_{MAX}}{h_s}$
$\phi_{MIN} = \tan^{-1} \frac{R_{MIN}}{h_s}$
$\theta = \phi_{MAX} - \phi_{MIN}$
$f = \frac{h_c}{2 \tan(\theta/2)}$
h_s = SENSOR HEIGHT
h_c = FOCAL PLANE CHIP HEIGHT
$\alpha = 90° - (\frac{\theta}{2} + \phi_{MIN})$
f = FOCAL LENGTH OF SENSOR LENS
h_s
θ/p
θ/p
$\theta/2$
$\theta/2$
ϕ_{MIN}
ϕ_{MAX}
θ
α
R_{MIN}
LOS
R_{MAX}

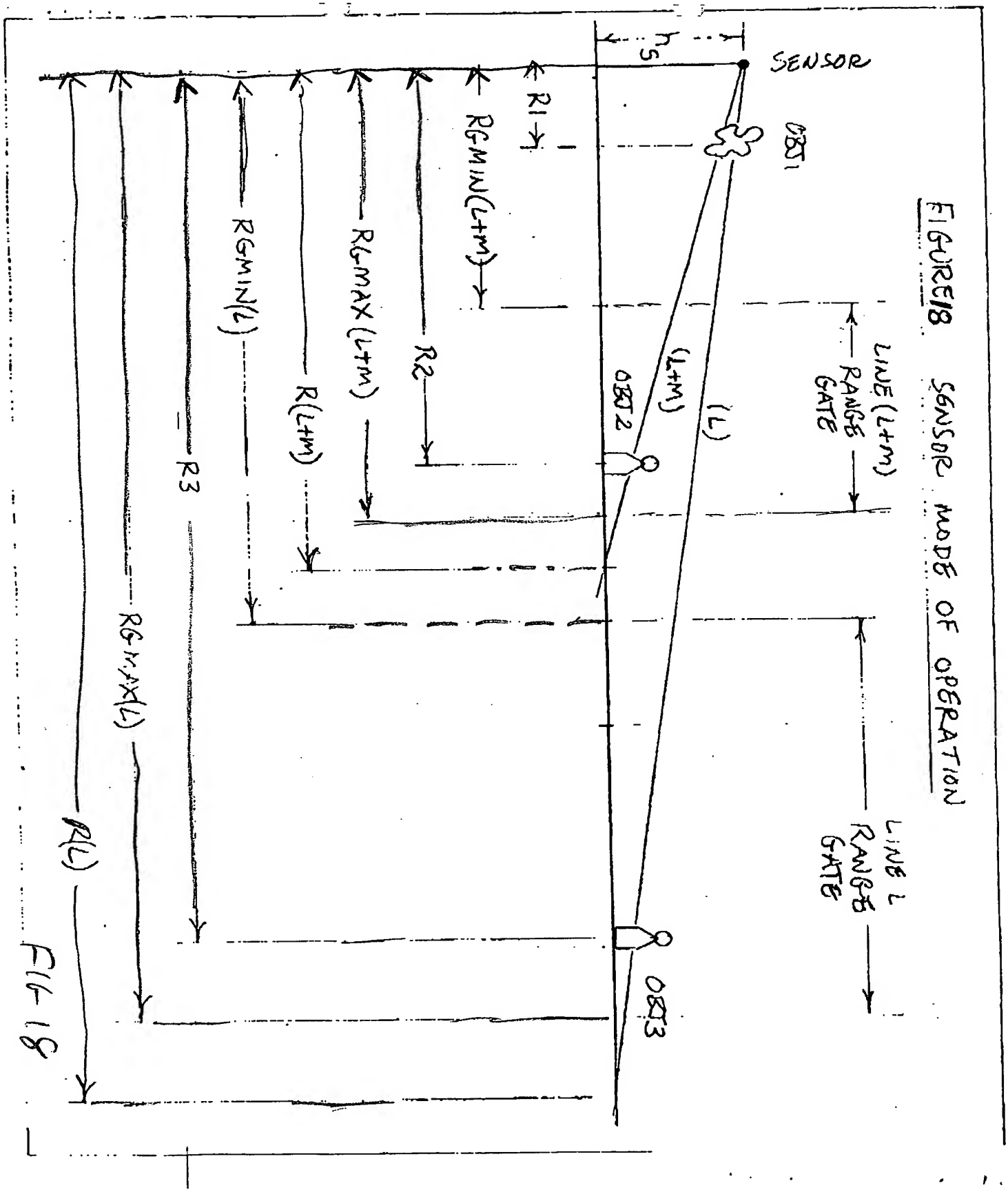
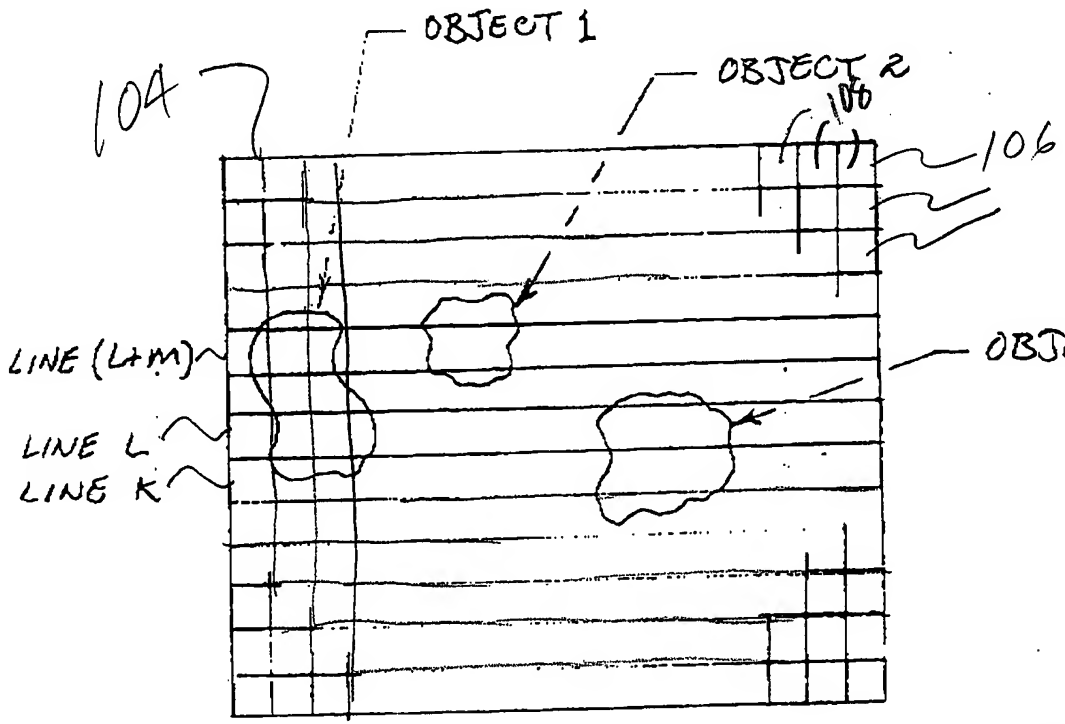


FIGURE 18 SENSOR MODE OF OPERATION

FIG 18

FIGURE 19

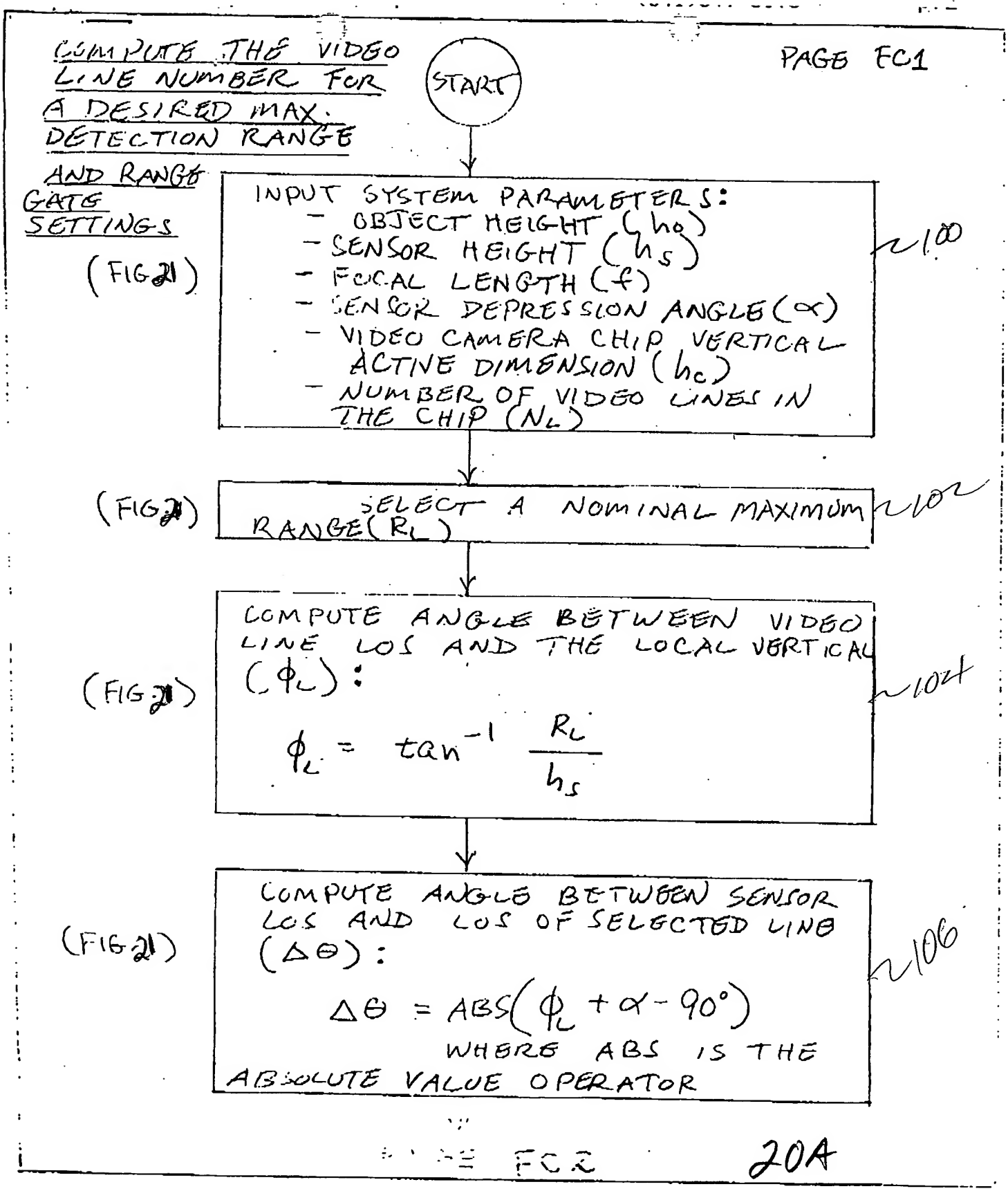
FOCAL PLANE CHIP PIXEL MAP *



(□ = 1 PIXEL)

*(ONE OF 2 CAMERAS)

FIG 19


COMPUTE THE VIDEO LINE NUMBER FOR A DESIRED MAX. DETECTION RANGE AND RANGE GATE SETTINGS
(FIG 21)
START
PAGE FC1
INPUT SYSTEM PARAMETERS:
- OBJECT HEIGHT (h_o)
- SENSOR HEIGHT (h_s)
- FOCAL LENGTH (f)
- SENSOR DEPRESSION ANGLE (α)
- VIDEO CAMERA CHIP VERTICAL ACTIVE DIMENSION (h_c)
- NUMBER OF VIDEO LINES IN THE CHIP (N_L)
~100
(FIG 21)
SELECT A NOMINAL MAXIMUM RANGE (R_L)
~102
(FIG 21)
COMPUTE ANGLE BETWEEN VIDEO LINE LOS AND THE LOCAL VERTICAL (ϕ_L):
$\phi_L = tan^{-1} \frac{R_L}{h_s}$
~104
(FIG 21)
COMPUTE ANGLE BETWEEN SENSOR LOS AND LOS OF SELECTED LINE ($\Delta\theta$):
$\Delta\theta = ABS(\phi_L + \alpha - 90°)$
WHERE ABS IS THE ABSOLUTE VALUE OPERATOR
~106

FROM PAGE FC1

COMPUTE Δh_c (THE LINEAR DISPLACEMENT FROM THE CENTER OF THE CHIP TO THE SELECTED LINE):

$$\Delta h_c = f \tan \Delta\theta$$

~108

(FIG. 21)

COMPUTE THE LINE NUMBER OF THE SELECTED VIDEO LINE (L_N):

$$L_N = \frac{N_L}{2}\left(1 + \frac{2\Delta h_c}{h_c}\right)$$

~110

COMPUTE THE VERTICAL DIMENSION OF A PIXEL (h_{pv}):

$$h_{pv} = \frac{h_c}{N_L}$$

~112

COMPUTE THE ANGULAR FOV OF A LINE (θ_{pv}):

$$\theta_{pv} = 2\tan^{-1}\left(\frac{h_{pv}}{2f}\right)$$

~114

(FIG. 22)

TO PAGE FC3

FIG 20B

BEST AVAILABLE COPY

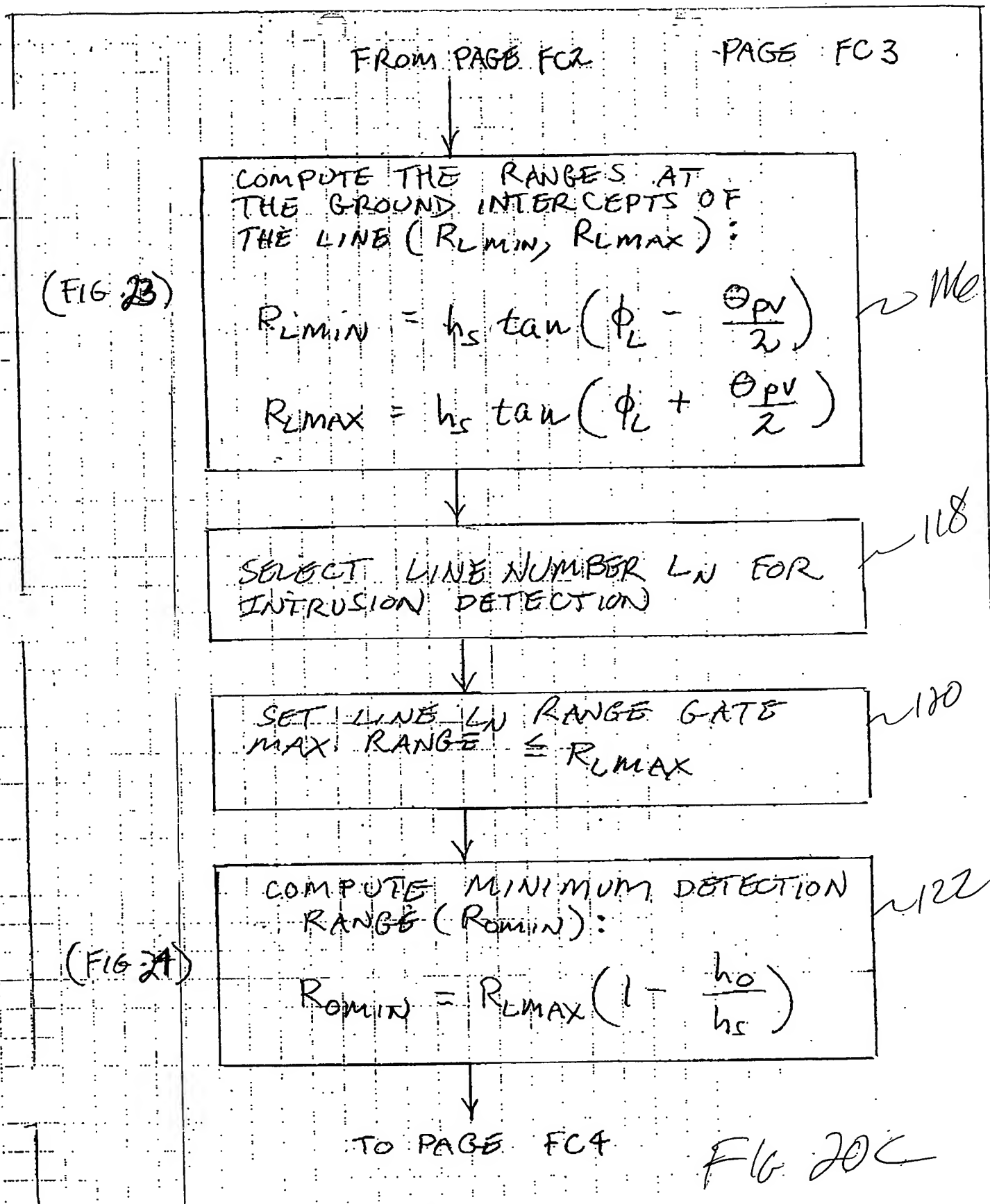


FIG 20C

BEST AVAILABLE COPY

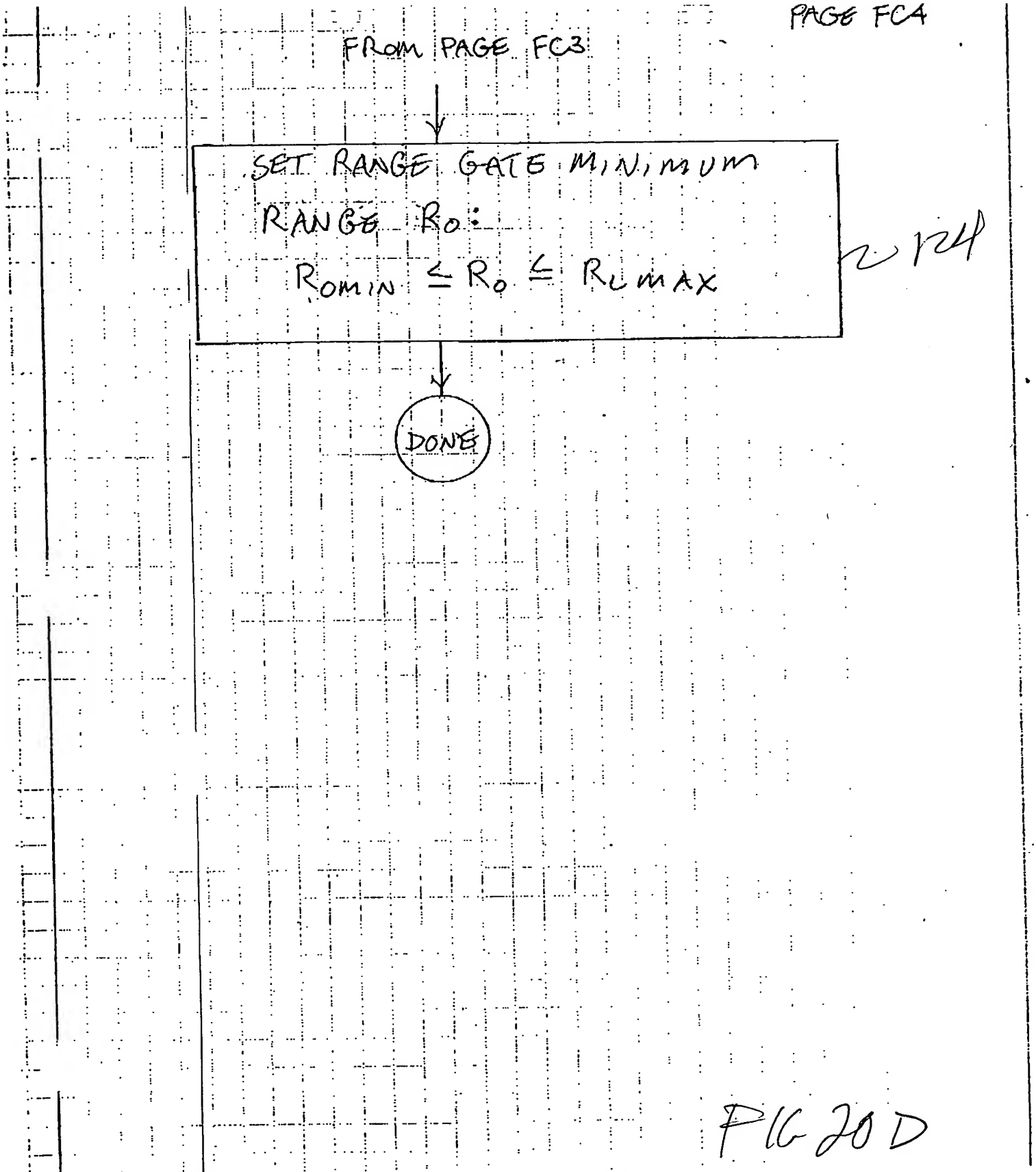


FIG 20D

BEST AVAILABLE COPY

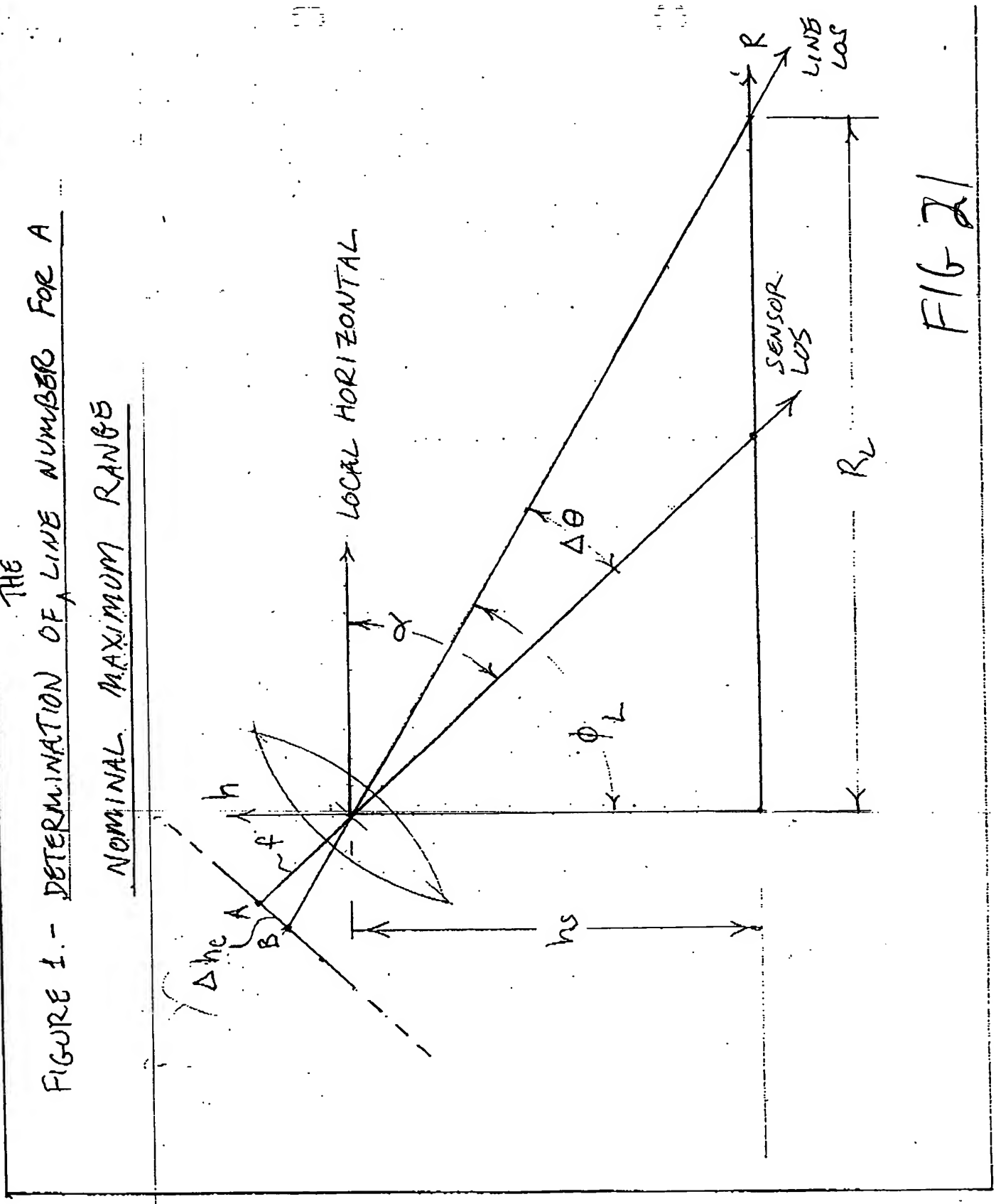
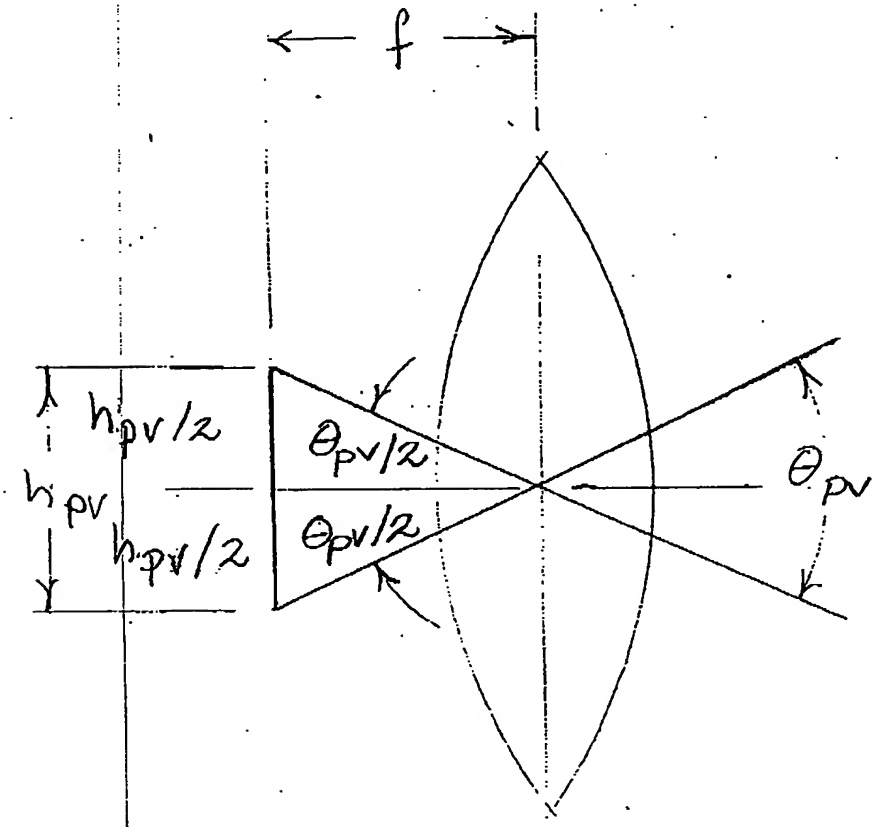


FIG 21

THE
FIGURE 1.- DETERMINATION OF A LINE NUMBER FOR A NOMINAL MAXIMUM RANGE

FIGURE 2.- VERTICAL ANGULAR FOV OF A LINE



$$\theta_{pv} = 2\tan^{-1}\frac{h_{pv}}{2f}$$

WHERE: θ_{pv} IS THE VERTICAL ANGULAR FOV OF A PIXEL

f IS THE FOCAL LENGTH

h_{pv} IS THE PIXEL HEIGHT

FIG 2A

FIGURE 3-... RANGE SPAN OF A VIDEO LINE

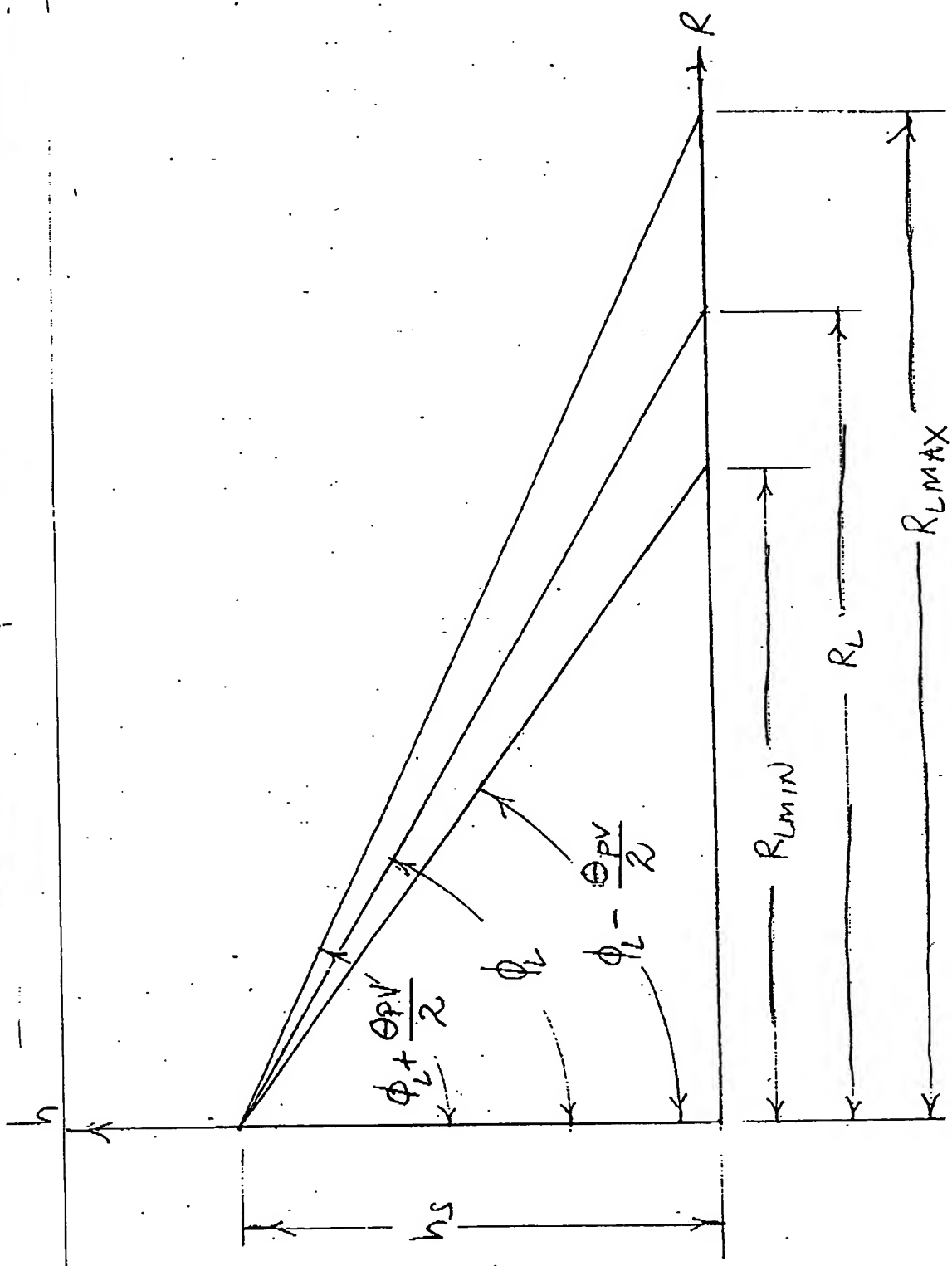


FIG 23

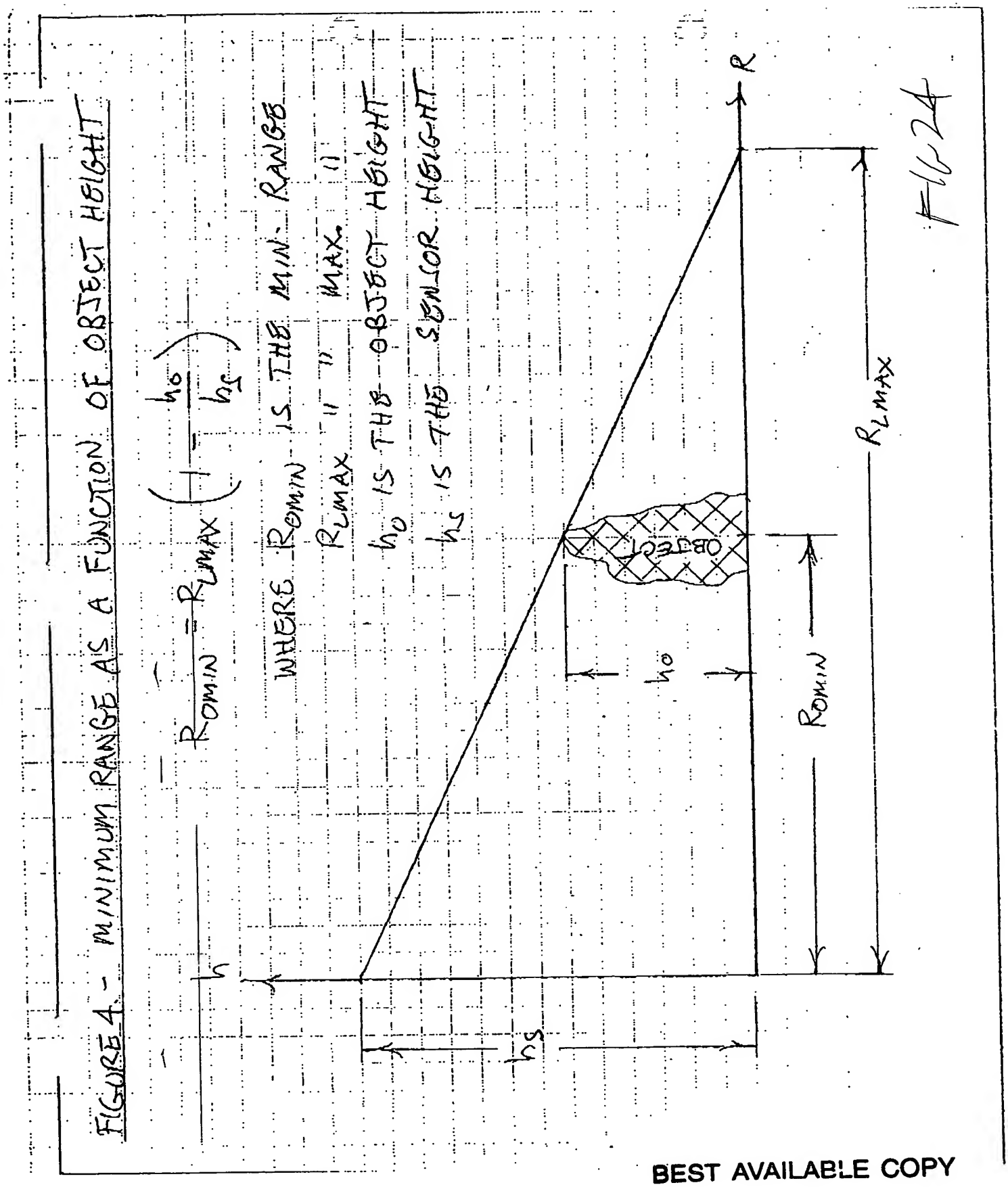


FIGURE 4 - MINIMUM RANGE AS A FUNCTION OF OBJECT HEIGHT

$$\frac{R_{OMIN}}{R_{LMAX}} = \left(\frac{h_O}{h_S}\right)$$

WHERE R_{OMIN} IS THE MIN. RANGE
R_{LMAX} " " MAX. "
h_O IS THE OBJECT HEIGHT
h_S IS THE SENSOR HEIGHT

Fig 4

BEST AVAILABLE COPY

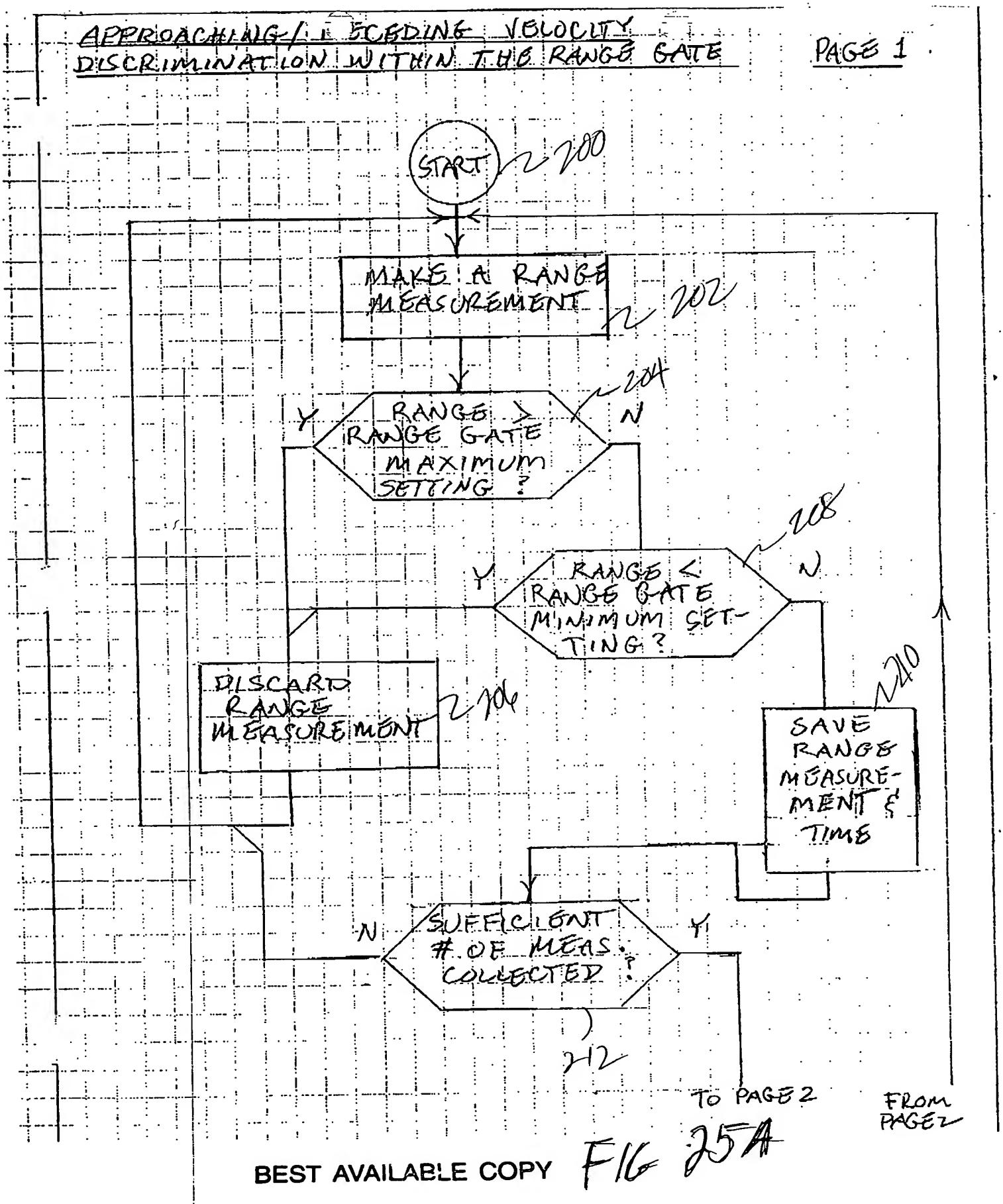


FIG 25A

BEST AVAILABLE COPY

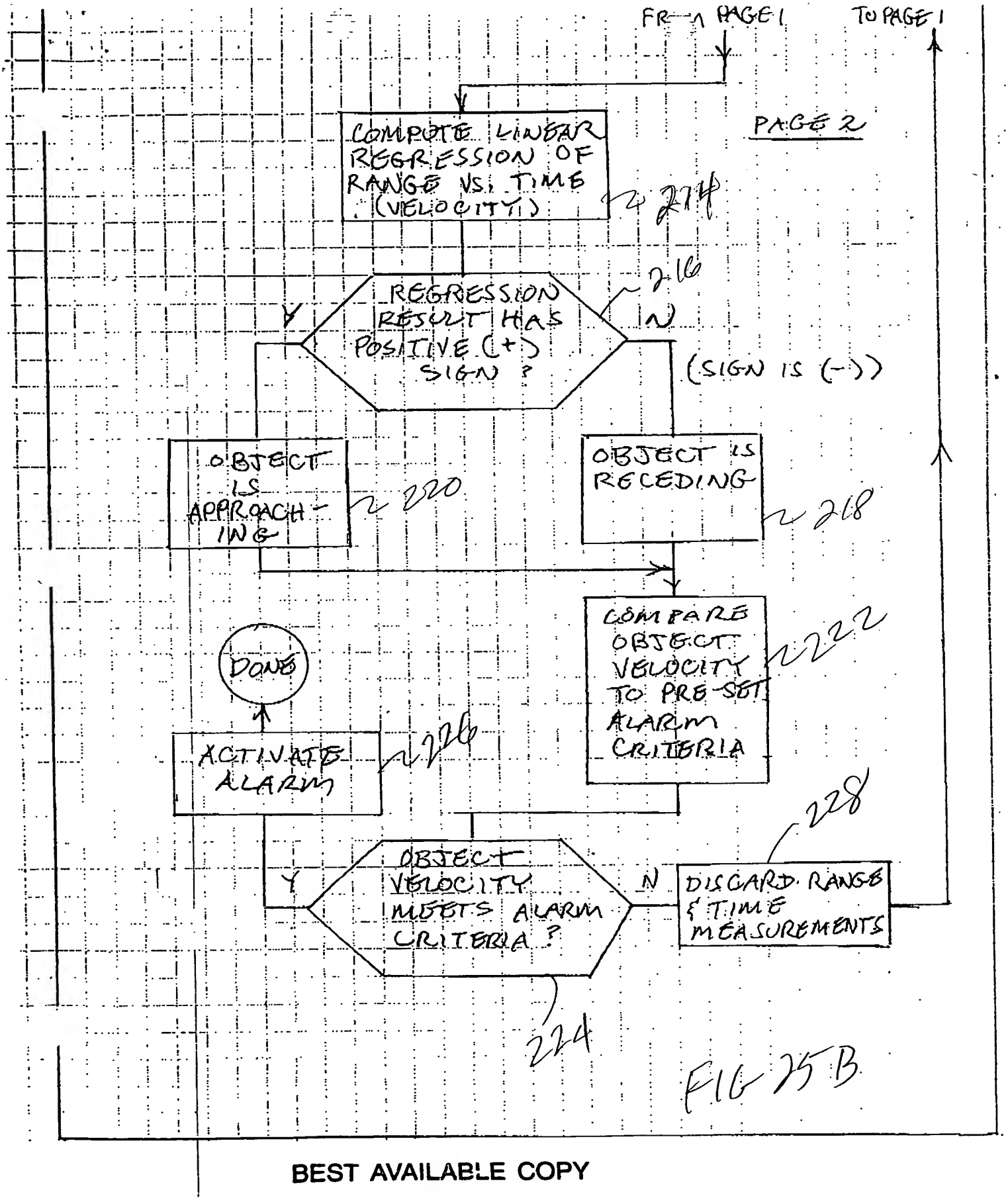


FIG 2B

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